The Integrator

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# A Message from the Associate Director / Program Manager for Mission Services

In the last edition of *The Integrator* I noted that the Mission Services Program (MSP) was working with Center-level management and our Flight Programs and Projects Directorate managers to reorganize the MSP. The reorganization was effective in December 2000, putting in place changes that will enhance the quality of service provided to our customers and aligning the MSP with the SOMO program structure. Its focus on the customer interface function will help enable early mission involvement and increase our effectiveness in responding to our customers' needs and requirements. The reorganization also focuses on technology and upgrades allowing the organization to maximize opportunities to insert new technologies and operations concepts in a timely, cost-effective fashion. All of the changes instituted position the organization for a leadership role in implementing the strategic direction of the Agency. Details about the reorganization and descriptions of the newly formed Projects and Offices are included within.

December 2000 marked the termination of the Extreme Ultraviolet Explorer (EUVE) after more than 8 years of successful operations. EUVE would have celebrated its fourth year of outsourced spacecraft operations at the University of California Berkeley this March. The EUVE operations team and support personnel at Goddard should be proud of their innovative role in automating operations, and of their significant contributions to science. Look for more information about EUVE inside.

As we move forward we will face many challenges and opportunities. Our staff are busy providing support for launches on the horizon, including MAP, HESSI, TIMED, Aqua, and QuikTOMS. We will continue to provide mission support for the assembly of the International Space Station. We are well positioned to exploit technology to influence mission success.

Upcoming critical mission activities and technology initiatives will be demanding over the next few months. I am confident that we will continue to remain a vital component of our Enterprise customers' missions, and that we will contribute to the successful implementation of NASA's goals.

*Phil Liebrecht*

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# Mission Services Program Elements

## Mission Services Program Office Reorganizes

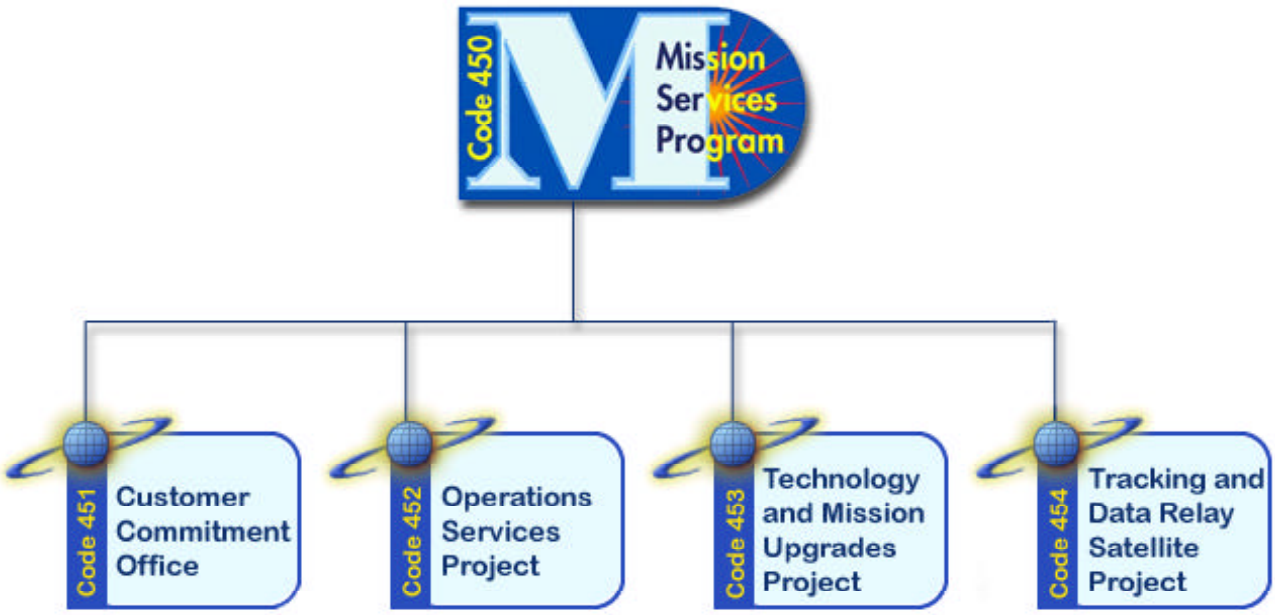
The Mission Services Program Office (MSPO) was reorganized in December 2000 to focus specifically on Space Operations Management Office (SOMO) support, and to align its organization with elements of the SOMO program. The reorganization will facilitate focus on customer interfaces by emphasizing early mission involvement. Also significant is the raised stature of technology and product development to the Project level.

The objective of the MSPO is to enable scientific discovery and technology and commercial space development by delivering responsive services to NASA enterprises, and national and international scientific and aerospace partners. The goals of the MSPO are to provide mission optimized end-to-end tracking and data communications capabilities; experienced, comprehensive flight mission operations; and delivery of TDRS Replenishment spacecraft on-orbit. To meet the full mission life cycle needs of its customers, the MSPO is organized by function into Projects and Offices, including the Customer Commitment Office (Code 451), the Operations Services Project (Code 452), the Technology and Mission Upgrades Project (Code 453), and the Tracking and Data Relay Satellite Project (Code 454). These Projects and Offices are responsible for supporting new and future mission planning, systems development, and infusion of new technology. Additionally, the MSPO provides its customers with leadership, management, and technical expertise in coordination with Goddard Directorates, SOMO, and other NASA Centers.

MSPO leadership includes the Associate Director/Program Manager for Mission Services (Phil Liebrecht), the Deputy Program Manager (Roger Flaherty), the Customer Commitment Manager (To Be Named), the Business Manager (Dennis Vander Tuig) and the Deputy Program Manager for Resources for SOMO Services (Linda Price). Also resident in the MSPO is the GSFC Spectrum Manager (Badri Younes).

The MSPO will continue to pursue its goals by utilizing proven management tools to identify and monitor individual and crosscutting commitments, and to safeguard against risk. The MSPO reorganization is congruent with the MSPO's long-standing commitment to providing best value engineering support and delivery of services to its customers, and rewarding career opportunities for Mission Services Program staff.

*For additional information regarding the Mission Services Program Office, contact Phil Liebrecht via telephone (301-286-5220) or email (Phil.Liebrecht@gsfc.nasa.gov).*



## Code 451: The Customer Commitment Office

The newly created Customer Commitment Office (CCO) provides a single interface for customers utilizing Space Operations Management Office (SOMO) services. Dedicated CCO staff members are available to assist customers throughout the mission life cycle. In the formulation phases, CCO representatives help Principal Investigators and Mission Formulation Managers define mission requirements, and evaluate potential service options. To aid in effective mission planning, the CCO may perform trade studies and cost analyses. The CCO also enables project managers to secure contract vehicles to obtain the communications, flight operations, and data processing services needed to meet mission goals. In addition, during the development, implementation, and operations phases, the CCO provides project management assistance. At any time during the above activities, CCO personnel may call upon CSOC Customer Service Representatives to provide the required services.

Previously, Code 450 Mission Managers were not consolidated in a single organization—they were distributed in different branches throughout Code 450. Customers and CCO staff members, alike, will benefit from the new streamlined communications processes.

Recent CCO accomplishments include establishing and documenting the processes used to generate Project Service Level Agreements (PSLA). CCO staff and customer representatives are also currently refining the methods employed to produce and baseline detailed mission requirements.

*For further information on the Customer Commitment Office, or related topics, please contact Jon Z. Walker via telephone (301-286-7795), or email (Jon.Z.Walker@gsfc.nasa.gov).*

## Code 452: The Operations Services Project

During the December 2000 reorganization, the Operation Services Project (OSP) was formed by consolidating elements from the former Space Network (SN), Ground Network (GN), and Mission and Data Systems branches. Code 452 is responsible for managing NASA's SN and GN tracking and data acquisition facilities and services, and the data and mission operation services required for space flight missions. In so doing, the OSP will strive to provide these services in a cost effective manner, while simultaneously fully addressing current and future customer needs.

Among the services OSP provides are:
- Systems planning and management for testing and simulations
- Network compatibility testing
- Flight operations
- Tracking, data acquisition, and command capability
- Data processing and distribution

Resources under OSP auspices include:
- Tracking and Data Relay Satellite System (TDRSS) constellation
- White Sands Complex (White Sands Ground Terminal, Second TDRSS Ground Terminal, and Guam Remote Ground Terminal
- Network Control Center
- GN sites in the continental U. S., Alaska, Norway, Bermuda, Merritt Island, and Antarctica
- Mission Operations Centers and Science Data Processing Facilities

Many of the services and facilities that the OSP is responsible for are provided or maintained via the Consolidated Space Operations Services Contract (CSOC). Code 452 personnel work closely with the CSOC contractors and other service providers to ensure that OPS goals and customer needs are met.

While the role and responsibilities of these newly joined entities have not altered significantly, stakeholders will realize several advantages from their union. Now that space operations management is more centralized, a cadre of Code 452 personnel can specialize in the management of these services and facilities. Management expertise can be efficiently applied, and benefits of commonalities realized. Code 450's new organization parallels that of the Space Operations Management Office (SOMO), clearly establishing lines of communication between SOMO, customers, contractors, and the NASA Centers.

*For additional information regarding the Operation Services Project, please contact John Jackson via telephone (301-286-4924).*

## Code 453: The Technology and Mission Upgrades Project

The Technology and Mission Upgrades Project addresses the future needs of the Mission Services Program (MSP) customers. The Project's goal is to ensure that the appropriate mission and data services are in place to enable the science objectives of GSFC missions for the next twenty years. In addition, when developing these services, Code 453 seeks to utilize commercial services whenever it is appropriate and cost effective to do so.

The Project consists of four focus areas, which work in concert to ensure Project goals are achieved. In the first area, the Architecture Evolution Planning/System Engineering area, Project staff examine the strategic plans of the NASA Enterprises to determine the science objectives for the upcoming two decades. They then derive a list of mission and data services that will be required to accomplish those objectives. A roadmap is currently being developed (see article on page 15) which describes the customer needs and identifies the corresponding technologies and upgrades necessary to fulfill them. This information drives the work performed in the other three areas of the Project, ensuring that all Code 453 efforts can be directly traced to a future customer need.

Often, it is determined that a new service is required, for which the technology does not currently exist. In these cases team members in the Technology area work to develop the expertise needed to achieve future customer objectives. Deliverables for this area usually consist of demonstrations or papers proving the new technology. Examples of some technologies currently under development include a capacity for spacecraft downlink at 1 Gigabyte per second, and the development of cost effective flight operations capabilities for multi-satellite systems. For more information on new technology development in Code 453 see the article on page 18 about the OMNI project.

The role of the third Technology and Mission Upgrades Project area, the Standards area, is to promote the use of standards within the technology development community. It is vital to ensure that emerging technologies are optimized to prevent expensive duplication of resources in the future. For example, to achieve spacecraft downlink at 1 Gigabyte per second, it will be necessary to implement one of several advanced modulation techniques. The chosen technique must be one which can potentially be accommodated by NASA, other government agencies, international space agencies, and the industries that may be providing the services in the future. Personnel in the Standards area work closely with these parties to ensure proper standards are established and used. Additional information on work ongoing in the Standards area can be found on page 15.

The fourth Project area involves implementing Upgrades to enable new service capabilities. The government's role is to lead or oversee upgrades that infuse new technology. Actual implementation of upgrades may be accomplished via the Consolidated Space Operations Contract (CSOC), other commercial vendors, or by the civil service work force.

The role of the Technology and Mission Upgrades Project is consistent with the MSP's renewed emphasis on the customer. The newly established technology identification and development process, and the clear lines of communication among customers, SOMO, and Code 453 promise to benefit all parties involved.

*For additional information regarding the Technology and Mission Upgrades Project, contact Roger Clason via telephone (301-286-7431) or email (Roger.Clason@gsfc.nasa.gov).*

## Code 454: The Tracking and Data Relay Satellite Project

The roles and responsibilities of the Tracking and Data Relay Satellite (TDRS) Project were not altered by the December reorganization of Code 450. The Project continues to manage three separate TDRS programs: TDRS-A through F (the first six TDRS spacecraft), TDRS-G (the spacecraft that replaced TDRS-B, which was destroyed in the Challenger accident), and TDRS-H, I, J (spacecraft to replenish the TDRS constellation).

After the successful launch of TDRS-H (now referred to as TDRS-8) on June 30, 2000, Project engineers became involved in an extensive acceptance testing program for that spacecraft. The test program has successfully demonstrated both the on-orbit spacecraft performance, including the new Ka-band service and the H,I,J unique White Sands Complex ground station modifications. Although the spacecraft state-of-health remains excellent, the on-orbit acceptance has been delayed to allow engineers time to investigate a slight underperformance of the TDRS-8's Multiple Access (MA) return service.

Code 454 Project staff is now preparing for the launch of the next satellite, TDRS-I. This spacecraft, also built by the Boeing Satellite System (formerly the Hughes Space and

Communications Company), is tentatively scheduled for launch in Fall 2001.

*For additional information about the TDRS Project, please contact Lyle Tiffany/TDRS Deputy Project Manager via telephone (301-286-5678), or email (lyle.e.tiffany.1@gsfc.nasa.gov).*

## McMurdo TDRS Relay System II Installed

The installation of a second TDRS relay terminal in Antarctica was completed in February 2001. It is located near the town of McMurdo, and will enable year-round servicing, if needed. Code 450 and the EOS Aqua Project (GSFC Code 420) provided joint funding for this work. It is expected that Aqua will use the terminal for relay of 150 Mbs data through the McMurdo Ground Station (MGS). The output from the MGS will be sent to a new disc data storage system also funded by Code 420. Because the McMurdo TDRS Relay System II (MTRS II) does not have 24-hour visibility of TDRS 171, the data will be stored and then played back to the White Sands Complex during the approximately ten hours that TDRS 171 is visible. The maximum data rate capability of MTRS II is 300 Mbs.

The system consists of a refurbished 4.6M Ku Band antenna [from the original Gamma Ray Observatory (GRO) Remote Terminal System (GRTS) system] housed on a platform, and a radome loaned by the National Science Foundation, and installed by the Raytheon Polar Services Corporation. Andre Fortin and Dave Israel of Code 450 developed new software for the terminal. Integration of the hardware was performed by Fred Frey of Honeywell. The installation team consisted of civil servants Andre Fortin, Joe Stevens, and Kevin Ballou; support contractor Bill Schmidt; Jesse Paul Sigmund of Andrew Corporation; and Kevin Culin from TSI Incorporated.

MTRS II (a.k.a the “beach ball”), located near McMurdo, Antarctica

The system can be controlled and operated by remote control from a work station in the Crary Lab in downtown McMurdo. There is fiber connectivity to/from Crary for data and control. Periodic updates of TDRS vector information will allow the MTRS II antenna to perform successful TDRS 171 pointing and tracking.

The initial testing indicates that the system is performing about 2 db better than expected. The plan is to continue to perform routine testing through the next six months, in preparation for Aqua launch, currently scheduled not earlier than September 2001.

*By Frank Stocklin/GSFC Code 451*

*For additional information about MTRS II, contact the author via telephone (301-286-6339), or email (frank.stocklin@gsfc.nasa.gov).*

## Network Control Center News

The Network Control Center (NCC) has several ongoing Data Services Management Center (DSMC) related activities and significant operational accomplishments to report for this issue of *The Integrator*.

Since October 1, 2000, the NCC has supported seven Expendable Launch Vehicle launches and three Space Shuttle missions.

The NCC move to the White Sands Complex (WSC)—i.e. the DSMC effort—has begun. Six consoles, six workstations, six monitors, and one printer were picked up for shipment to WSC in support of DSMC Phase 1. Seven Multi-conferencing Digital Switch (MDS) console phones, six I/O boards, and cable were shipped to WSC to support expansion of their phone system. NCC Operations personnel continue to work with WSC staff on Technical Manager/Performance Analyst (TM/PA) tasks that have moved to WSC as part of Phase 1 of the DSMC transition. Once the total transition of all NCC Operations is complete, the support area located at the White

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Sands Complex will be known as the Data Services Management Center. This transition is scheduled to be complete in Spring of 2002.

The NCC is working with security personnel to develop the NCC Security Plan and a Risk Assessment. This plan and assessment will answer many of the findings / recommendations discovered during the Office of Inspector General's audit that occurred last year.

The NCC Technical Manager (TM) position is now the point of contact for Wallops Flight Facility (WFF) customer/site problem reporting and coordination. The TM will be the single point of contact, during periods when the WFF is not staffed, and will obtain ground station status to escalate problem reporting if deemed appropriate. The TM will use the Site Contact Escalation list to contact the appropriate WFF personnel.

The NCC successfully demonstrated a complete failover to the Auxiliary NCC (ANCC) and the Communications and Control Segment (CCS) #3 backup string. This occurred on November 4 – 16 and was the first time since the delivery of NCC 98 that a complete failover was attempted.

The CCS Replacement (CCSR) hardware arrived and is now installed in the NCC. The current CCS system will be rehosted on the newer hardware in preparation for the transition of NCC operations to the White Sands Complex.

*By Joe Snyder/ATSC*

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## NCCDS Maintenance Status and Future Plans

The third Maintenance Release of the Network Control Center Data System 98 (NCCDS 98), dubbed Release M00.3, transitioned into operations on February 20, 2001. This release is the major component of the NCCDS maintenance effort. The contents of this release included solutions to 92 problem reports and 16 NCC Change Requests (NCRs). One of these NCRs documents the software changes needed to implement NCCDS support of Ka-band "Wide Band" (i.e., 650 MHz) services. These services are part of a demonstration of the capabilities of Ka-band services for both the Space Network and the Ground Network. The M00.3 changes will allow Ka "Wide Band" services to be defined in the database, scheduled, and transmitted to the ground terminals and the Mission Operations Centers (MOCs). The second part of this implementation, which is the real-time monitoring and control of "Wide Band" services, will be completed in a follow-on release.

The NCCDS continues to prepare for its move to the White Sands Complex (WSC) to become the major component of CSOC's Data Services Management Center (DSMC). As part of this preparation, the Communications and Control Segment (CCS) and the NCC Test System (NTS) are being rehosted onto more appropriate hardware platforms.

The CCS Rehosting effort will replace the current VAX 8550 platform with a VAX 6610, which is a platform more compatible with the existing WSC VAX equipment. The first VAX 6610 cluster has been integrated into the system test suite and is currently being tested. The second cluster will be integrated into the Auxiliary NCC (ANCC) to undergo Operations Evaluation Testing (OET) beginning in March. This new platform will be transitioned into NCC operations in late June 2001.

The NTS Porting effort is similar in purpose to the CCS Rehost; that is, migrate to a platform that is more effective for the DSMC. The new NTS system is still under development. Customers using this system will appreciate the results of the porting effort—a more integrated system with a more customer-friendly interface. Excellent progress continues to be made with respect to delivering the more modern test system in early April. The test system will be validated and certified through testing by the OET team. This effort is to be completed in late June.

With the rehosted CCS baseline delivered to system test, the modifications for Ka "Wide Band" Phase 2 changes have started. This release, CCS Release M01.2, will require modifications to both the VAX component and the HP component of the CCS. These modifications will be developed and delivered to system test sometime in April 2001. After being fully tested by both test groups, these changes are planned to be operational in the NCCDS by August 2001. This baseline will subsequently become part of the DSMC baseline.

The influence of the DSMC efforts will become much more visible through this period. The most significant impact will be the complete dismantling of the test and training (T&T) equipment suite. This set of equipment is to be used for the initial buildup of the DSMC operational network. This "tear down" will not only result in a big empty room, it will also limit all of the testing of the NCCDS software with the ANCC suite. This change will alter the use and configuration of the ANCC equipment, as it will become home to all system testing activities, OET activities, EIF testing, and the backup operations facility.

The DSMC effort will influence the operational environment in the NCC. Change requests will be evaluated very conservatively. This conservative attitude will continue until the DSMC becomes operational in February 2002.

*By John Russell/CSC*

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## New Level-Zero Processing System Implemented – Others on the Way!

January 3 marked the transition to operations of a new level-zero processing system for the Solar and Heliospheric Observatory (SOHO) mission. The SOHO Data Processing System (DPS) represents a step forward in level-zero processing system automation and data processing algorithm improvements beyond the services previously provided by the Packet Processor (Pacor) II system. SOHO data processing had been performed by Pacor II since the launch of SOHO in December 1995. The SOHO DPS architecture is based on a proven design already in use for many other missions, and soon to be in use also for the Rossi X-ray Timing Explorer (RXTE). The RXTE DPS, currently under development and testing, will transition to operations over the next few months. RXTE also has been supported by Pacor II since its launch in December 1995.

Also based largely on the DPS architecture is the Pacor Automation system (Pacor-A), which is currently under development and testing. Pacor-A will provide level-zero processing support for the Hubble Space Telescope (HST), Tropical Rainfall Measuring Mission (TRMM), Upper Atmosphere Research Satellite (UARS), and Earth Radiation Budget Satellite (ERBS) missions, and will phase into operations beginning this summer.

With the implementation of these new level-zero processing solutions, many of the legacy systems currently supporting these six missions will be decommissioned. Specifically, the TDRSS Interface Preprocessor Into Telops (TIPIT), Generic Block Recording System (GBRS), Generic Recording System (GRS), Data Distribution Facility (DDF), and Pacor II systems will no longer be required for routine operations, resulting in a significant cost savings.

The next six months will be an exciting and challenging time as GSFC's Science Data Processing organization moves into a new era of providing level-zero processing and distribution services to its many customers.

*By Brian Repp/HTSI*

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## Commercial Tracking Stations Expand the Ground Network

NASA's polar orbiting science satellites have additional commercial telemetry, tracking, and command (TT&C) support. NASA and CSOC have integrated two new commercial tracking stations into the Ground Network. Honeywell's DataLynx station, known as PF1 at Poker Flat, Alaska, and Konsberg Lockheed Martin, Space Data System (KLM/SDS), known as SKS at Svalbard, Norway, are fully operational elements of the GN.

PF1 and SKS successfully completed Operational Readiness Reviews (ORRs) on November 15 and 16. They were immediately challenged by the launch the following week of EO-1 and SAC-C. Both stations provided launch and early

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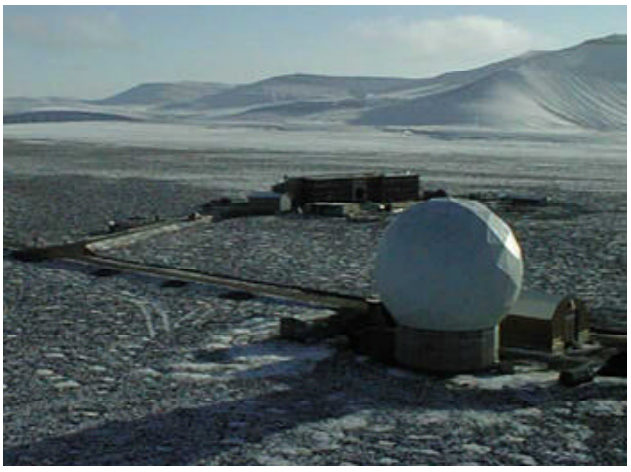

Svalbard Ground Station 11 meter antenna and building in background

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orbit support followed by extended orbital support from SKS.

These stations are elements of the CSOC commercialization initiative offering additional, cost effective capacity to NASA's GN. Future GN commercialization initiatives include the potential of commercial services for Shuttle launches at Kennedy Space Center, new VHF services for one of our oldest and most distinguished science spacecraft, IMP-8, and new services provided by Universal Space Networks for the Triana mission.

The new commercial services have proved to be excellent additions to the GN. PF1 is operated from a Honeywell control center in Columbia, Maryland, while SKS is operated from a Lockheed Martin control center in Seabrook, Maryland. The sites are fully autonomous and require no on-site staffing for routine operations. Recently, PF1 received a compliment from our QuickScat customer – "The entire ground network has been performing at 98.4% on time delivery. We are very impressed with the performance of DataLynx which is the only ground station with a perfect record." (Jack Faber, Spacecraft Operations Engineer, LASP)

There are additional changes planned for both Svalbard and Poker Flat. In a recent change of ownership, Lockheed Martin has sold its share of the KLM/SDS operations to the Norwegian Space Centre. As a result the Seabrook control center is being moved to a new home in Tromso, Norway. This transition should be completed by April 2001. The current contract between NASA, Code 450, and the Norwegian Space Centre for the operations of the Svalbard Ground Station (SGS) will be moved to CSOC this summer. CSOC also plans additional commercialization initiatives at Poker Flat and Svalbard which would place both sites under the management of a commercial service provider. These transition activities are in the planning stage and NASA will review the business cases for polar consolidation and commercialization in the Spring of 2001.

Stay tuned for more about the introduction of commercial services on our networks in the next edition of *The Integrator*.

*By Bill Brooks/Windermere ITS*

*For additional information, please contact the author via email at wbrooks@witsusa.com*

# Mission Services Program Customers

## RXTE Points at Black Hole

A black hole, designated XTE J1550-564 for its right ascension and declination, has unexpectedly grabbed attention again.

After its first detection by the Rossi X-ray Timing Explorer (RXTE) in September of 1998, the singularity declined in intensity (in terms of x-ray luminosity) for two months, and then became bright once more. Its brightness did not subside again until June 1999. In addition, a nearby star was discovered using optical means by a Yale University consortium, and radio jets were discovered using the Molongo radio telescope array in Australia. Then the source was quiet for a year, until June 2000, when it grew bright again, although only a sixth as bright as it did the first time. Optical measurements have identified that its binary period is 1.5 days, but the mass of the black hole has not yet been determined. RXTE results suggest it is greater than seven solar masses.

On January 28, 2001, the RXTE Proportional Counter Array (PCA) pointed at the source again, not expecting to see x-rays, but to obtain a background measurement. To everyone's surprise the source was bright again. Optical observers studied the source and also found it bright, although not at peak brightness. Radio observations have also taken place for verification.

It is not known whether the disk surrounding the black hole is only going to dribble a little into the black hole this time, or whether it is going to take off, and really stream in as it did before. RXTE continues to monitor this exciting phenomena . The source flares by a factor of two on a time scale of two minutes. This is the kind of behavior black holes exhibit in what is called the "low" state (which is a lot brighter than the "quiescent state").

*By Federico Sanidad/RXTE Lead Engineer*

*For additional information on the RXTE mission, please contact the author via telephone (301-286-6132) or email (Federico.Sanidad@gsfc.nasa.gov).*

## TOPEX/Poseidon and Jason-1 Formation Flying

The U.S.-French TOPEX/Poseidon satellite continues to operate well, as the mission passed its 8 1/2 year operational milestone in February. Attention is now focusing on Jason-1, the follow-on mission to TOPEX/Poseidon. Jason-1 is also part of an international partnership agreement between NASA and the French Space Agency CNES, and is scheduled to launch in the summer of 2001.

When TOPEX/Poseidon launched in 1992, only the most optimistic Project scientists envisioned that the satellite would maintain full operations until a follow-on project could be launched. At that juncture, an oceanography radar altimeter follow-on mission was only a concept without a name. Given TOPEX/Poseidon's three to five year design life, it seemed there would inevitably be a data void between altimeter missions. Now that the Jason-1 launch is finally here, scientists and oceanographers around the world are eagerly anticipating a "tandem" mission between the two satellites.

To take full advantage of the well-calibrated instruments on TOPEX/Poseidon, Jason-1 will target its launch to occupy the same operational orbit. Jason-1 will "lead" or "lag" TOPEX/Poseidon by 1-10 minutes, and overfly the same surface ground track. This operational spacecraft arrangement is termed "formation flying"; mission objectives of a common nature are achieved by two or more satellites positioned in a closely coordinated orbit and/or pattern. In this case, the calibration and validation of Jason-1 instruments will be accelerated and enhanced by cross-correlation with TOPEX/Poseidon data.

After a six month calibration period, the TOPEX/Poseidon orbit will be modified to increase overall science data quantity and quality. This tandem mission phase will last a minimum of one year, and many new scientific discoveries will be enabled by this unique data. In the meantime, the flight team earnestly is preparing for Jason-1 operations here at the JPL Earth Science Mission Center, where we also currently monitor the TOPEX/Poseidon, ACRIMSAT, and QuikSCAT satellites. Although the TOPEX/Poseidon satellite is currently operating with several degraded or failed hardware systems, we have been able to substitute redundant components or design operational alternatives in all cases. The Project remains optimistic that the satellite will remain healthy through the launch of Jason-1, and accomplish the tandem mission that was only imagined just a few years ago.

Artist's rendering of the Jason-1 satellite, which is about one-fifth the size of TOPEX/Poseidon

*By Mark Fujishin/Manager, JPL Earth Science Mission Operations*

*For further information on TOPEX/Poseidon or Jason-1, please contact the author via email (mark.fujishin@jpl.nasa.gov). More information about TOPEX/Poseidon is available on the WWW (http://topex-www.jpl.nasa.gov).*

## Sea Launch Ready To Rock and Roll!

Expendable Launch Vehicle (ELV) activity has been relatively quiet for the past few months, but that will change with the anticipated launch of XM-2/Rock and XM-1/Roll satellites. "Rock" and "Roll" are the names of the two satellites that are scheduled to launch in March and early May of this year.

XM-1/Roll was originally scheduled for launch in early January of this year and almost made it off the pad, only to see the launch scrubbed in the final minute of the count. Unfortunately, the late call on the scrub rendered the first stage of Sea Launch unsuited for a second attempt. The launch vessels were forced to return to home port in California for an engine swap out. XM-2/Rock will now move ahead of XM-1/Roll in the launch schedule.

XM™ Satellite Radio was founded in 1992 as American Mobile Radio Corporation. The company was renamed XM™ Satellite Radio Inc. in 1998. Their two satellites "Rock" and "Roll" are designed to provide state-of-the-art digital audio radio directly to XM-capable radios in cars, homes and

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portable radios anywhere in the United States. Imagine driving coast-to-coast and never changing the radio station in your car!

Sea Launch was chosen to launch "Rock" and "Roll" in part for its unique ability to launch heavy payloads from a seagoing platform situated on the equator in the Pacific Ocean. From its launch location at 154 degrees West longitude, Sea Launch can provide a launch into any inclination, and the location on the equator allows for maximum use of earth mechanics to launch heavy vehicles into orbit. The XM spacecraft are Boeing Satellite Systems 702 model satellites weighing in at approximately 10,324 lbs each, with expected lifetimes of 15 years. Both vehicles will be placed in geosynchronous orbit 22,326 miles above the earth. XM-2/Rock will be inserted directly into orbit at 115 degrees West Longitude.

XM™ Satellite Radio Inc. is based in Washington, D.C., and will be charging a monthly fee for the satellite digital radio service. More details are available at *http://www.xmradio.com*.

Now for additional news regarding Expendable Launch Vehicles: Technical Interchange Meetings (TIM) with Boeing (Delta IV), NASDA (H-IIA), and CNES/Arianespace (Ariane 5) are scheduled this spring. The Delta IV TIM will be held at the Boeing launch facility at Cape Canaveral Air Force Station on March 14 and 15. The first Delta IV launch is planned for March 2002.

*By Joe St. John/Lockheed Martin*

*For further information, please contact Ted Sobchak via telephone (301-286-7813) or email (Ted.Sobchak@gsfc.nasa.gov).*

## The Termination of EUVE: End of a Scientific Era

NASA's highly successful Extreme Ultraviolet Explorer (EUVE) mission has finally come to an end. Although reentry into the Earth's atmosphere is not predicted until March 2002, EUVE science and mission operations were officially terminated at U.C. Berkeley (UCB) on 31 January 2001. Until the very end, and after more than 8.5 years on orbit, the satellite continued to be fully functional, with all subsystems performing exceptionally well. Although known for innovation in mission operations automation, and for its vanguard role in educational and public outreach, EUVE's core legacy will be its excellent and unique scientific contributions. With the demise of the EUVE mission comes the end of a scientific era, as there is no other ground- or space-based observatory—either in operation, in development, or in the planning stages—that will carry on after EUVE to perform dedicated research in the unique field of extreme ultraviolet astronomy.

Examples of EUVE's unique and exciting scientific contributions continue to appear. Dr. David Ciardi (University of Florida) and colleagues recently reported on their EUVE observation of the magnetic cataclysmic variable system HU Aquarius. This stellar system was 30-60 times brighter in the extreme ultraviolet than ever before seen. The detailed structure in the resulting EUVE "light curve" (see Figure 1), which shows the system's emission as a function of orbital phase, traces both the size and geometry of the EUV-emitting "hot spot" that is located on the surface of the white dwarf.

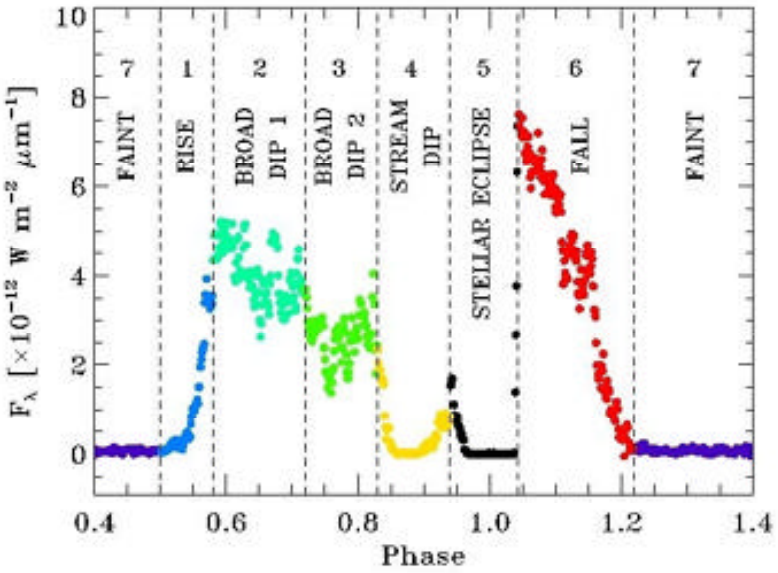


Figure 1: Phase-binned EUVE light-curve of the magnetic cataclysmic variable, HU Aquarius

In another example, Dr. Eric Gaidos (Jet Propulsion Laboratory) and colleagues reported a very large and unusual flare during a single orbit of the EUVE observation of the solar-like star HD 43162. As seen in EUVE's deep survey imaging detector,

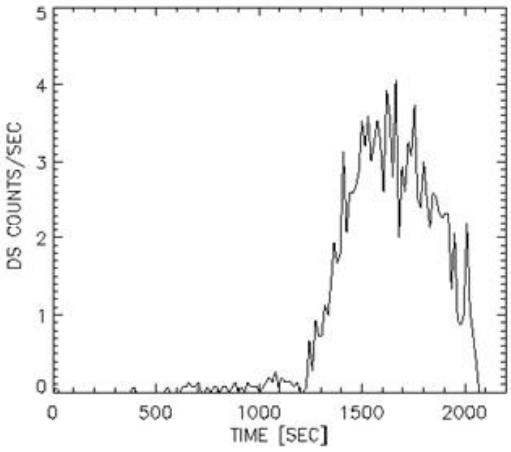


Figure 2: EUVE light-curve of the unusual flare on the solar-like star HD 43162

the EUV flare (see Figure 2) was of very short duration (~15 minutes) and was accompanied by an increase of hundreds of times the usual EUV intensity level. The flare also showed significant structure, and was particularly bright at the longer EUV wavelengths. This latter result was very puzzling and completely unexpected for this type of star unless it has a hidden companion, which the authors deemed very unlikely based on other measurements. Information on past and present EUVE science highlights are available on-line at *http://www.cea.berkeley.edu/~science/html/Resources_high.html*

Science and mission operations continued to be challenging for the EUVE Flight Operations Team (FOT). During the mission's final four months of observing (October 2000 - January 2001), the EUVE satellite conducted 37 pointings at 13 individual celestial targets. Noteworthy among these observations was a move to a safe attitude to ride out the Leonid Meteor Storm in November, and the final series of science calibrations, which were used to check the throughput and wavelength scale of the seven EUVE imaging and spectroscopic instruments. During this period the EUVE spacecraft also entered a safe-pointing mode on three occasions. And, last but not least, the final few days of operations were spent conducting end-of-life/end-of-mission tests. Throughout, the rate of EUVE science data collection on the ground continued to be excellent at greater than 98%.

The FOT's final operational activities occurred on the last day of EUVE mission operations. On 31 January the Project held a "celebratory wake" in the EUVE control center at UCB. The event was well-attended by local EUVE affiliates, two representatives from NASA Headquarters, and a number of others from GSFC and elsewhere via telephone. A live "Webcam" was also set up to help non-local persons participate in the festivities. Figure 3 shows the "last light" image from EUVE, which is signed by a number of wake attendees. The FOT had scheduled communications via the omni antennae right up to the official mission termination deadline at 00:00 GMT on 1 February. Just prior to this deadline the FOT commanded the spacecraft to safe-hold mode, and at 23:59 GMT reconfigured the spacecraft's transponder, after which telemetry contact was lost.

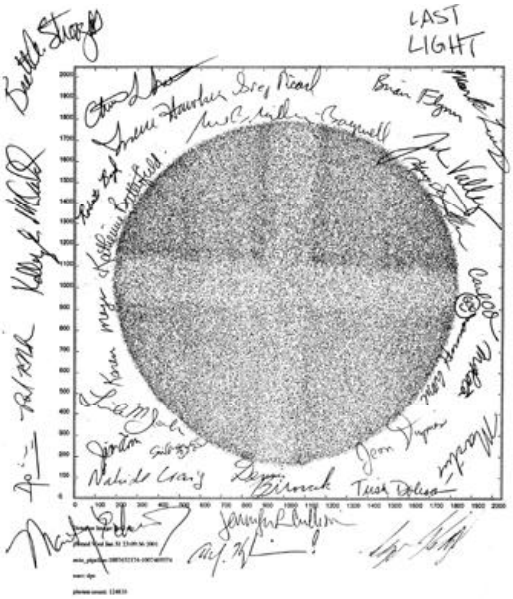


Figure 3: The "last light" image from EUVE, signed by attendees of the EUVE "wake" held on January 31, 2001 in the EUVE control center at UCB

However, the mission refused to end! The FOT left the EUVE transmitter on via the low-gain omni-directional antennae, so that EUVE's radio frequency (RF) signal could be used to help test out the ground station at UCB for its soon-to-be-launched High Energy Solar Spectroscopic Imager (HESSI) mission. However, after the official mission termination on 31 January, GSFC management decided to turn off the EUVE transmitter, to minimize the possibility of it causing RF interference for other satellites. So, after much ado to repower the UCB and GSFC ground systems, and reestablish the communications link, at 21:18 GMT on 7 February the FOT said its last words to EUVE and commanded the transmitter off. The spacecraft was then set adrift: in safe-hold mode, with the transponder in TDRSS-compatible mode with transmitters off and receivers on via the omni antennae. EUVE will remain in this configuration until it finally reenters the earth's atmosphere, which is currently predicted to occur in March 2002.

In the end, after more that 8.5 years in orbit, how best can one sum up the EUVE mission?—as a resounding success!! At the mission's core was a terrific satellite—one that remained fully functional until the "bitter end." In fact, EUVE exceeded its planned lifetime by over five years! The final legacy of EUVE will be its wealth of excellent and important scientific contributions, its significant innovation in mission operations

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automation, and its precedent-setting role in educational and public outreach.

In closing, the EUVE Project at UCB would like to offer hearty congratulations and sincere thanks to the many, many persons, both past and present, who were associated with this tremendously successful mission. The entire EUVE team can be proud of a job very well done! We at UCB feel very honored and privileged to have been given the opportunity to run the mission for the past four years, and it is with mixed feelings that we terminated it: with joy at EUVE's scientific and technical excitement, opportunity, and challenge, yet with sadness in the premature loss of an old and true friend.

*By Brett Stroozas/EUVE Project/Mission Manager*

*For more information, please visit the UCB/CEA WWW site (http://www.cea.berkeley.edu) or contact the author via telephone (510-643-7312) or e-mail (bretts@cea.berkeley.edu).*

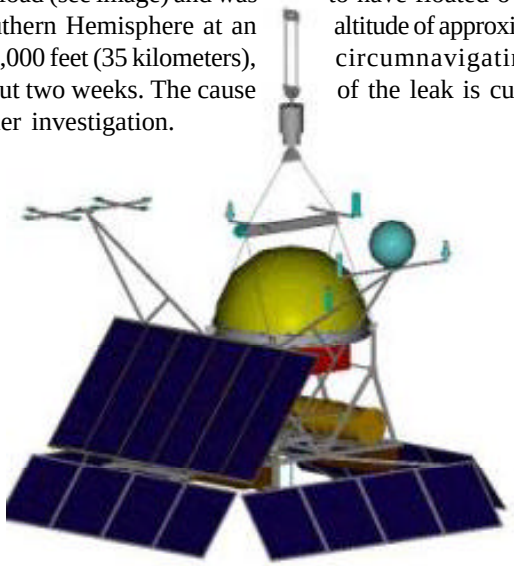
## Landsat-7 Mission Continues

Since the October 1, 2000 transition of operations responsibility from NASA to the United States Geological Survey (USGS), the Landsat-7 spacecraft continues to be in excellent health, fulfilling its mission of mapping the land surface of the Earth. Although the Landsat-7 operations control center remains in Building 32 at GSFC, the effort is managed by the USGS, out of the Earth Resources Observation Systems (EROS) Data Center in Sioux Falls, South Dakota.

Additional information about the Landsat-7 program and sample data to view or purchase are available on line at *http://landsat7.usgs.gov/*

## Ultra Long Duration Balloon Mission Terminated

The Ultra Long Duration Balloon (ULDB) Project was forced to abort a recent ULDB flight after a leak occurred in the balloon. The mission lifted off on February 25, and prematurely concluded approximately four hours into the flight. The balloon carried an LDB payload (see image) and was to have floated over the Southern Hemisphere at an altitude of approximately 115,000 feet (35 kilometers), circumnavigating for about two weeks. The cause of the leak is currently under investigation.



ULDB Australia Test Flight Payload

A separate balloon mission planned for January 29, 2001 from Antarctica, which was to carry both ULDB and Long Duration Balloon (LDB) Transponders, was cancelled due to various reasons. This mission would have been the first time that ULDB and LDP communications equipment were supported from the same balloon craft. Thorough testing conducted in the dual configuration was conducted, and no problems were expected. Unfortunately, this dual configuration is not expected to be scheduled again soon.

Balloon missions are controlled from the ULDB Operation Control Center (ULDBOCC) located in the National Scientific Balloon Facility (NSBF) in Palestine, Texas. The ULDBOCC uses the Space Network (SN) Web Services Interface (SWSI) demonstration system to schedule and control SN services. The ULDB uses the White Sands Complex (WSC) Transmission Control Protocol /Internet Protocol (TCP/IP) Data Interface Services Capability (WDISC) to receive balloon telemetry, and send balloon commands via the SN. At this time, ULDBP Engineers plan to upgrade the software

at ULDBOCC to allow the operator the ability to be selective in configuring equipment for transmitting command data.

The ULDBP is managed by Goddard Space Flight Center's Code 820/Balloon Program Office. The ULDBP supports various scientific experiment campaigns, which vary from flight to flight. The Trans-Iron Galactic Element Recorder (TIGER) experiment—the first ULDB payload—is scheduled for December 2001.

*By Danh Nguyen / Lockheed Martin*

*For additional information, check out the ULDBP web site at http://www.wff.nasa.gov/~uldb/index.html, or contact Ted Sobchak via telephone (301-286-7813) or email (Ted.Sobchak@gsfc.nasa.gov).*

# Additional Activities

## Code 450 Technology and Upgrades Roadmap in Progress

Code 453, the Technology and Mission Upgrades Project, continues to formulate a roadmap depicting the evolution of the space operations architecture for GSFC. As described in the November 2000 issue of *The Integrator*, Technology and Mission Upgrades Project personnel will gather Center-wide input for the roadmap and periodically update its contents. The roadmap will provide direction for future GSFC technology investment. In addition, NASA's Space Operations Management Office (SOMO) will utilize the roadmap in conjunction with information from other NASA centers to produce an architecture evolution roadmap for the entire Agency.

To produce Goddard's roadmap, Code 453 is examining the science objectives that the NASA Enterprises have specified for the next 25 years. These objectives will be the drivers for all space operations technology or upgrade efforts undertaken at GSFC. Currently, the roadmap effort is focused on identifying a basis for all current projects, to ensure that they effectively support customer needs or overall agency and enterprise goals (such as cost savings, or the need for increased network capacity).

As work on the roadmap proceeds, look for additional information in future issues of *The Integrator.*

## GSFC Participates in Standards Development

Concerned about the increasing costs of supporting space missions, members of the NASA staff established the Consultative Committee for Space Data Systems (CCSDS) in 1982. The committee's objectives are straightforward:

- Provide a forum to promote the exchange of technical information relative to common space data transport and information interchange systems problems
- Seek standard solutions (called Recommendations) to these problems that are optimized to succeed in a true space environment
- Promote adoption and implementation of these solutions by member agencies to minimize mission risk and costs, and maximize mission performance associated with data and information systems

Members from all international countries with major space programs were invited to participate in CCSDS and, since its very beginning, GSFC personnel have been instrumental in CCSDS activities.

While NASA has always performed as Secretariat, CCSDS activities have grown to a point where over 100 industry associates provide support, and liaisons are established with numerous international organizations and academia.

In the past 20 years, the CCSDS has proved itself to be both extremely productive, and widely accepted. It has published some 26 Recommendations relating to all aspects of space

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data and information systems, including, telemetry, telecommand, navigation, data archiving, data access and retrieval, and data interpretation. These Recommendations are also published as ISO international standards. Collectively, CCSDS Recommendations have been accepted for use by over 150 space missions, and companies produce over 50 CCSDS-compatible products.

While detailed information can be found on the CCSDS Web Site at *http://www.ccsds.org/*, GSFC support to the CCSDS program is summarized below.

CCSDS Panel 2, known as the "Standard Information Interchange Process" panel, addresses Recommendations designed to improve the exchange, archiving, and understanding of data. This panel has developed standard languages, data packaging approaches, and data management services which facilitate the ability of both humans and processes to improve the exchange and preservation of data. Recent efforts have focused on the development of the "Reference Model for an Open Archival Information System (OAIS)," which provides a framework of terms, concepts, and responsibilities that are used in archives to improve the ability to manage and preserve information. Another focus for this panel is the development of a "Data Entity Definition Specification Language (DEDSL)," which establishes a framework for documenting the meaning, units, data types, etc., of data elements and their collections. [Technical contact: Donald Sawyer/GSFC/Code 564]

Sub-Panel 1J, "Navigation Data," is responsible for defining recommendations for standards applicable to the exchange of navigation data. GSFC staff serve as sub-panel chairman, lead workshops, and develop documents to describe the recommendations for the exchange of navigation data. In addition, panel members present status reports to Panel P1, the Technical Steering Group (TSG), and the NASA Technical Advisory Group (NTAG). Team members are currently working on a green book for navigation definitions, and a white book for orbit data messages. Further documents, in the areas of attitude, proximity operations, environmental models, and astrodynamic constants, will be developed. [Technical contact: Felipe Flores-Amaya/GSFC/Code 572]

GSFC personnel also serve as members of a sub-panel that establishes CCSDS standards in several disciplines, including Telecommand, Channel Coding, Lossless Data Compression and Modulation. Panel members also encourage development of technologies to demonstrate and implement the CCSDS standards. [Technical contact: Warner H. Miller/ GSFC/Code 564]

Another CCSDS sub-panel supports the compression working group, and a GSFC staff member serves as the chairperson. Work from this panel contributes to the analysis and improvement of the CCSDS lossless compression algorithm, and the writing of Recommendations. GSFC is leading the sub-panel effort in performing analysis and selection of a lossy image compression algorithm for spacecraft use. [Technical contact: Pen-Shu Yeh/GSFC/Code 564]

GSFC staff are also involved in the CCSDS File Delivery Protocol (CFDP) SOMO Task, working on the production of a reusable core CFDP library, based on the State Tables defined in the draft CFDP standard. [Technical contact: Tim Ray /GSFC/Code 584]

*By Felipe Flores-Amaya/GSFC Code 572*

*For more information on this subject, contact the author via email at fflores@pop500.gsfc.nasa.gov.*

## Safety: Our #1 Priority!

The Missions Services Program continues to implement NASA's drive to make safety our first priority. With the reorganization, new Safety Managers were appointed for each Project. The Customer Commitment Office effort is led by Susan Naylor. Mellani Edwards and Diane Rawlings provide safety direction to the Operations Services Project. Leading the safety effort for the Technology and Mission Upgrades Project is Cheryl LaDow. Barbara Sweeney continues to manage the safety initiatives for the TDRS Project. Finally, Rosemary Bruner is providing support and direction to each of the Project Safety Managers, as well as the Program Office. Varied monthly topics are presented throughout the Program, and they often include safety bulletins, checklists, questionnaires, and discussions. Each Project conducts a quarterly walk-through of its work areas to assure hazards are eliminated.

A particularly important initiative was conducted in late fall. There was a general perception that Building 12 air quality was not optimum, evidenced by a large number of colds, allergy flare-ups, and even pneumonia. In response, the Health and Safety Office was contacted. Questionnaires were distributed throughout the building, respondents were interviewed, air handlers were inspected, environmental conditions were monitored, and air samples were collected.

All readings were within normal limits, with the exception of widely fluctuating room temperatures throughout the building. Jay Leung, the Health and Safety Office representative who conducted the research, did recommend that the Heating, Ventilation, and Air Conditioning (HVAC) system in Building 12 be studied to determine whether its design is adequate to provide heat and cooling for building residents.

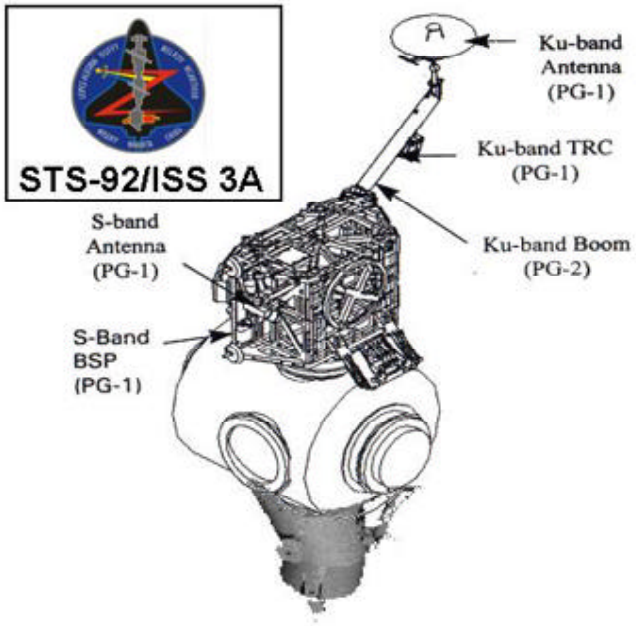
Stay tuned….more safety news will be reported in future issues of *The Integrator*.

*By Rosemary Bruner/GSFC Code 450*

*For further information on safety in Code 450, please contact the author via email (Rosemary.V.Bruner.1@gsfc.nasa.gov) or telephone (301-286-2648).*

## ISS Communications Capability Expands

Building the International Space Station (ISS) is exciting! The success of STS-92/ISS 3A, and the transport of the ISS Z1 Truss with equipment for the Core S- and Ku-Band communication systems, set the stage for completion of major communications milestones.




ISS ZI Truss with K-Band and S-Band RF equipment attached to Node 1

With the installation of portions of the core system equipment, STS-97/ISS 4A opened the door for installation of the P6 Integrated Equipment Assembly (IEA) on Z1, and the activation of the S-Band Low Data Rate (LDR) capability. This mission provided the first U.S. solar power, with solar arrays/batteries, radiators for early cooling, and a TDRSS transponder for S-band Voice and Telemetry configuration.

The STS-98/ISS 5A mission also provided new communication capabilities. Objectives for the mission included installation of the U.S. Lab "Destiny," activation of the Control Moment Gyroscopes, installation of the critical space S-band RF group, and activation of the High Data Rate (HDR) S-Band system. With the installation of the critical RF group and the activation of the HDR, the ISS Core S-Band communication system is now complete. The Networks have provided Single Access services to the ISS using the new system, and all indications are very positive.

The upcoming STS-102/ISS 5A.1 mission, scheduled for March 8, 2001, is also very important in this series of communications events. This mission will include activities such as the transfer of Expedition Crew 2, and the return of Expedition Crew 1 to Earth; berthing the Multi-Purpose Logistics Module (MPLM), known as Leonardo; and most importantly to the Mission Services Program (MSP), the activation of the ISS Ku-Band core system. Network preparations for ISS 5A.1 have been extensive. For return link services, a new circuit was installed, and Line Outage Recorders (LOR) were implemented at the White Sands Complex (WSC). For the forward link, additional devices were installed at WSC for the interface with JSC.

It is a busy time for the ISS program, and the MSP will continue to work to meet the communication needs of this important program.

*By John Smith/LM*

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## NASA Engineers Use Standard Internet Protocols To "Surf a Satellite"

NASA's Goddard Space Flight Center (GSFC) Operating Missions as Nodes on the Internet (OMNI) project, in collaboration with Surrey Satellite Technology Limited (SSTL) and Vytek Wireless, demonstrated the use of standard Internet World-Wide Web protocols and applications in a space flight environment. These tests were performed with SSTL's UoSAT-12 spacecraft. A new milestone was achieved on January 25, 2001, when a web server activated on-board UoSAT-12 provided real-time telemetry and an image of a lunar eclipse that had been acquired January 9, 2001, by the spacecraft. This is the first time that a web server has been used onboard a spacecraft to deliver real-time telemetry displays and instrument data directly to operators on the ground.

The web server on the spacecraft was implemented by VyTek Wireless for the limited processing environment of real-time systems such as UoSAT-12. It was designed to fit, along with the rest of the flight software, in less than one megabyte of memory, and run on the 20 Mhz Intel 386 processor onboard UoSAT-12. The goal of this test was to investigate the use of a standard Internet web browser as a mechanism for retrieving telemetry data from a spacecraft (see figure). This approach reduces the amount of custom software required for individual missions, by enabling the monitoring and configuration of spacecraft subsystems and instruments using COTS software.

While the spacecraft was in view of the ground station in England, engineers from Computer Sciences Corporation, sitting at NASA GSFC, used standard web browsers on two different computers to access the spacecraft like any other node on the Internet. During the 12-minute test, the spacecraft never rose above a maximum elevation of 17 degrees above the horizon at the ground station, and the performance of the space-to-ground communication link never exceeded that of most home modem connections. All data packets were routed between GSFC and the spacecraft using standard Internet routing mechanisms, without any special modifications to accommodate the space environment. This test was one in a series of tests by the OMNI project investigating ways to use standard Internet protocols and communication technology to support the needs of future space missions.


Real-time UoSAT-12 spacecraft telemetry display via standard web browser

The OMNI project has been successfully testing and demonstrating the use of Internet Protocols in space for the last two years. The early demonstrations and tests used the Tracking and Data Relay Satellite System (TDRSS) Internet interface installed by the GSFC Code 450. This interface has been used by the South Pole TDRSS Relay (SPTR) project since 1997. The OMNI demonstrations consisted of simulated spacecraft operations using equipment installed in a van driving around GSFC, while communicating via TDRSS and the Internet. This equipment was later deployed on a cruise ship in the Black Sea in August of 1999 to provide a worldwide webcast of the last total solar eclipse of the 20th Century.

Following the ground-based experiments, Internet Protocol software was installed on the UoSAT-12 spacecraft, and was used to successfully test the first standard Internet connectivity to a spacecraft in April 2000. Further tests were performed using the Network Time Protocol (NTP) to synchronize the spacecraft clock and File Transfer Protocol (FTP) to upload and download files. In November 2000 the spacecraft delivered real-time UoSAT-12 telemetry to an Integrated Test and Operations System (ITOS) ground system at GSFC using standard UDP packets generated on the spacecraft and addressed to the ground system at GSFC. International interoperability was demonstrated by using both the SSTL ground station in England and a receive-only ground station installed at Stanford University. The packets from the spacecraft had a destination address of the OMNI project ground system, which ensured that they were automatically routed across the Internet and delivered to GSFC regardless of which of these two sites received the data.

The results of these tests have verified the basic capabilities and benefits of

using standard Internet Protocols for satellite communication. Further tests are underway to investigate the use of standard Internet Protocols to address additional satellite communication requirements for security, mobility, and reliable file transfers relative to a wide range of mission operations scenarios.

The OMNI project comprises engineers from GSFC's Information Systems Center (Code 580), Electrical Systems Center (Code 560), Mission Services Program Office (Code 450), Computer Sciences Corporation, Surrey Satellite Technology, Ltd., and VyTek Wireless. Funding for the project is provided by the Communications Technology Project of NASA's Space Operations Management Office.

*By James Rash/GSFC Code 588 and Keith Hogie/CSC*

*For further information on this project, please visit the OMNI website at http://ipinspace.gsfc.nasa.gov/, or contact James Rash via telephone (301-286-5246) or email (James.Rash@gsfc.nasa.gov); or Keith Hogie at (301-286-3203) or via email (keith.hogie@gsfc.nasa.gov).*

## GSFC's TILT Utilized in Ground Breaking Experiment

The space Internet is one step closer to becoming a reality. Satellite network research engineers from the NASA Glenn Research Center (GRC), NASA GSFC, and Veridian Information Systems (VIS) were part of an integrated team that successfully demonstrated a TCP/IP-based approach to command and control of on-orbit assets over a secure network. The demonstration took place at the Johnson Space Center (JSC) during Inspection 2000, on November 1-3, 2000. Phillip Paulsen, the project manager from the GRC/6150/Project Development and Integration Office organized the project into several components.

The demonstration consisted of the following integrated components:

- JSC-based emulated, Internet Protocol (IP)-compliant space experiment
- Emulated IP-compliant spacecraft network
- TDRS satellite uplink/downlink
- Virtual Private Network (VPN) connection between the TDRS System (TDRSS) White Sands Ground Terminal and JSC through the open Internet
- "Virtual" Mission Operations Center based at JSC and connected to the open Internet
- Web-based researcher control station (generic computer) with Embedded Web Technology
- Internet hacker prevention

A variety of networks had to be put in place for the demonstration to emulate the real world and real space environments. David Foltz, GRC/5610/Satellite Networks and Architectures Branch, provided the hybrid networking support for the Internet connections needed for this demonstration. The goal was to build a network that would emulate a connection between a space experiment on the ISS (International Space Station) and a researcher accessing the experiment from anywhere on the Internet.

Inside the demonstration area at the Johnson Space Center, the space experiment was interfaced to a wireless 802.11 network. The wireless link provided connectivity to the TDRS uplink terminal located 300 feet away in the parking lot on top of a panel van. The TDRSS Internet Link Terminal (TILT) provided a crucial link in this demonstration. TILT/TDRSS support was provided by Leslie Ambrose, GSFC/Code 451 and David Israel, GSFC/Code 567. TILT transmitted a signal to TDRS-6, which transmitted the signal to the White Sands Complex (WSC). The WSC provided the gateway to the Internet. Coordination also took place at WSC to install a Veridian Firewall and Automated Security Incident Measurement (ASIM) system to the WSC Internet gateway. Use of authentic NASA assets (the TILT terminal and the TDRS-6 satellite) greatly enhanced the demonstration.

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TILT terminal and GRC mobile router research van

TILT Terminal

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The Embedded Web Technology (EWT) required for the space experiment was provided by Joe Ponyik, GRC/7750/ Flight Software Engineering Branch. EWT enables space hardware to communicate with the Earth-based clients using a standard web browser. Mr. Poynik has been developing this technology and was able to provide an EWT space experiment called "Mars Atmosphere" for the demonstration (see *http://vic.lerc.nasa.gov* for more information). EWT will eventually be used to control experiments onboard the International Space Station.

To protect the space experiment from unauthorized Internet access, NASA worked with engineers from VIS to provide a layered security control system that ensured that only authorized NASA personnel were allowed access to the space experiment. The security layers included autonomous monitoring, three levels of VPN technology, command authorization, user authentication and prioritization, temporal testing of command knowledge and biometrics.

A second independent Internet connection at the JSC demonstration area was coordinated to provide Internet connectivity to a group of workstations which served as platforms for controlling the space experiment. This network simulated the researchers' home network interface to the Internet. Installation of this Internet connection was coordinated with GHG Internet Service Providers and local JSC personnel.

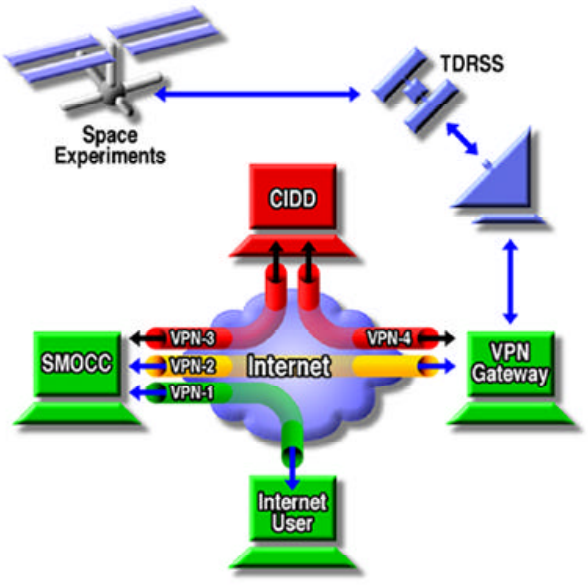
The diagram to the right illustrates the network flow through the Internet along with security processes that took place. The customer first logs onto the Internet, then establishes a VPN connection to the SMOCC (Secure Missions Operation Command Center) facility. After the customer is authenticated the commands are relayed to the VPN Gateway and Firewall located at the TDRSS uplink site in White Sands, New Mexico. All traffic in and out of the SMOCC and the VPN Gateway is monitored by the CIDD (Common Intrusion Detection Director). The purpose of the CIDD is to monitor and report suspicious Internet activity. The CIDD uses a VPN connection to the SMOCC and the VPN Gateway to terminate any suspicious activity that does not meet the multiple layers of network security specified for the mission. During the Inspection 2000 demonstration, several unplanned external hacking attempts were made from Tokyo to New York, but because of the security implementation scheme all of their attempts proved to be fruitless.

The TCP/IP-based architecture deployed at Inspection 2000 demonstrated that an authorized customer could securely utilize the Internet to command and control a web-enabled on-orbit asset. This demonstration moves NASA one step closer to deploying web-enabled technologies in space. This technology will benefit NASA in several ways, including reduced hardware costs, simplified Internet access to space experiments for our researchers, and the ability to provide valuable virtual testing over the Internet of planned missions prior to their deployment in space.

*By David Foltz/GRC Code 5610*

*For further information on this experiment, please contact the author via email at david.foltz@grc. nasa.gov.*

*For more information on TILT, please contact David Israel/ GSFC Code 567, via email at David.J.Israel.1@ gsfc.nasa.gov.*




Secure data flow for embedded web technology space experiments

## TDRSS Online Information Center

Have questions about TDRSS or the Space Network? Check out the TDRSS Online Information Center. We are continually renovating and improving the site. Our site now has a new "look," complete with updated navigation features. We have implemented a new search engine which can be directed to search the internal web site or the entire World Wide Web. For specific questions, use our feedback form to contact us; we will direct your question to the appropriate expert, and return an answer to you via email.

We have added a new information module that contains recent instructive presentations about Space Network capabilities, and we will add additional presentations and papers to this section as they become available. As always, the calendar listing upcoming launches and other activities of interest is updated monthly. We continue to maintain and support the link budget calculators, which will help determine if your mission can be supported by TDRSS.


The TDRSS Online Information Center can be found at *http://nmsp.gsfc.nasa.gov/tdrss/*

Detailed information is currently available on:

- The Tracking and Data Relay Satellites (including TDRS H, I, J)
- Demand Access
- The White Sands Complex including WDISC
- Guam Remote Ground Terminal
- McMurdo TDRSS Relay Terminal System
- TDRSS Telecommunication Services
- Customer Communication Systems and Products (including Transponders)
- TDRSS Applications
- PORTCOM, ECOMM and TILT
- Plus much more…

## Flight Modem Takes Off

The Flight Modem Project is part of the Advanced Range Technology Initiative (ARTI) managed from GSFC's Wallops Flight Facility. The Flight Modem is designed to enable a launch vehicle to transmit data directly to a remotely operated control center via the commercial space-based data network satellite system, Globalstar. See the data flow diagram on page 23. This new capability will provide an autonomous link for flight safety information, eliminating the need for a radar system for tracking, and resulting in cost and time savings.

The Flight Modem project is capitalizing on its first sounding rocket flight of opportunity with the Swedish Space Corporation (SSC) in Kiruna, Sweden. The launch date was February 19, 2001. The flight measured received signal strength from the Globalstar satellites, and performed a bit error rate measurement using the Markov loopback commands to the Finland gateway. Results of the flight are still being analyzed, but first indications reveal that 8 minutes and 15 seconds of data were logged. The flight modem automatically redialed at T+18 seconds due to a lack of connection at liftoff. At T+36 seconds a Markov command was successfully issued, and the connection was maintained for the next 8 minutes and 15 seconds through the initial burn, apogee, and initial chute deployment. Dropouts occurred around chute deployment. Data is still being analyzed to understand why these dropouts occurred. The flight has proven that it is possible to integrate COTS products that communicate over a commercial low Earth orbiting (LEO) satellite network for over-the-horizon data communication in a very dynamic environment and at altitudes of 100km.

GPS altitude, position, and time were recorded onboard, but not streamed, through the flight modem, due to the lack of a data-enabled gateway in Finland. Figure 2 shows the NASA rocket section that is mated to the SSC telemetry system. A single 7.5" Physical Science Laboratory (PSL) micro strip wraparound antenna provides the transmit (1618.5MHz) and receive (2492.5MHz) communications to the Globalstar satellite system. A 6" PSL wraparound micro-strip antenna provides the GPS communications.

The flight modem will undergo a series of aircraft tests using the E-9A from the Tyndall AFB in March 2001. The E-9A will fly off the coast of Florida in the Gulf of Mexico at altitudes ranging from 10,000 to 25,000 feet. Data will be streamed from the aircraft to a control center at the Wallops Flight Facility (WFF) using an Internet Protocol (IP) format. This test will be the first of its type, using a data enabled gateway in the U.S., and will represent the first data stream testing with commercial off the shelf (COTS) products and a commercial LEO satellite network (Globalstar). The next opportunity to conduct similar tests will be at Wallops Island, VA, using the WFF P-3 aircraft.

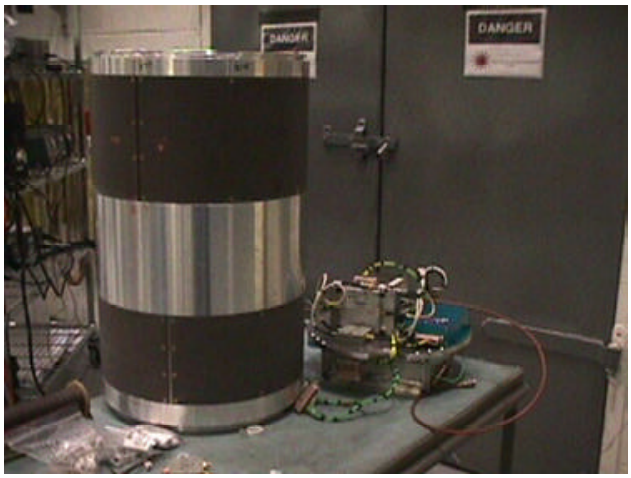



Figure 2: The NASA Skin section is depicted on the left with the Globalstar 7.5" wide wrap around dual frequency (Tx:1618.5MHz Rx: 2492.5MHz) micro-strip antenna at the top of the skin and a 6" GPS (1575.5MHz)wrap around micro-strip antenna at the bottom. To the right of the skin section is the deck plate structure. The flight modem is housed in an enclosure on the bottom of the deck plate while the top shows a GPS receiver, RF splitter, and PCM encoder.

Flight modem project personnel have published a paper entitled, "Telemetry Tracking & Control (TT&C) - First TDRSS, then Commercial GEO & Big LEO and Now Through LEO." The title is indicative of the progression of the space-based data platforms. The paper will be presented at the John Hopkins University (JHU)/Applied Physics Lab (APL) Fourth International Symposium on Reducing Spacecraft Costs for Ground Systems and Operations in Columbia, MD, on April 26, 2001. The paper focuses on the comprehensive test platforms and the results of terrestrial based testing that measured latency, bit error rate (BER) performance, and radio frequency interference (RFI) emissions. Flight modem project personnel have recently been selected to present a paper at the GPS-Differential GPS session at the International Telemetry Conference (ITC) in Las Vegas, NV, on October 22-23, 2001. The results of the sounding rocket launch and aircraft flight tests will be presented at that time.

*By Dwayne R. Morgan/GSFC/WFF Code 584.W*

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# Flight Modem Sounding Rocket Data Flow

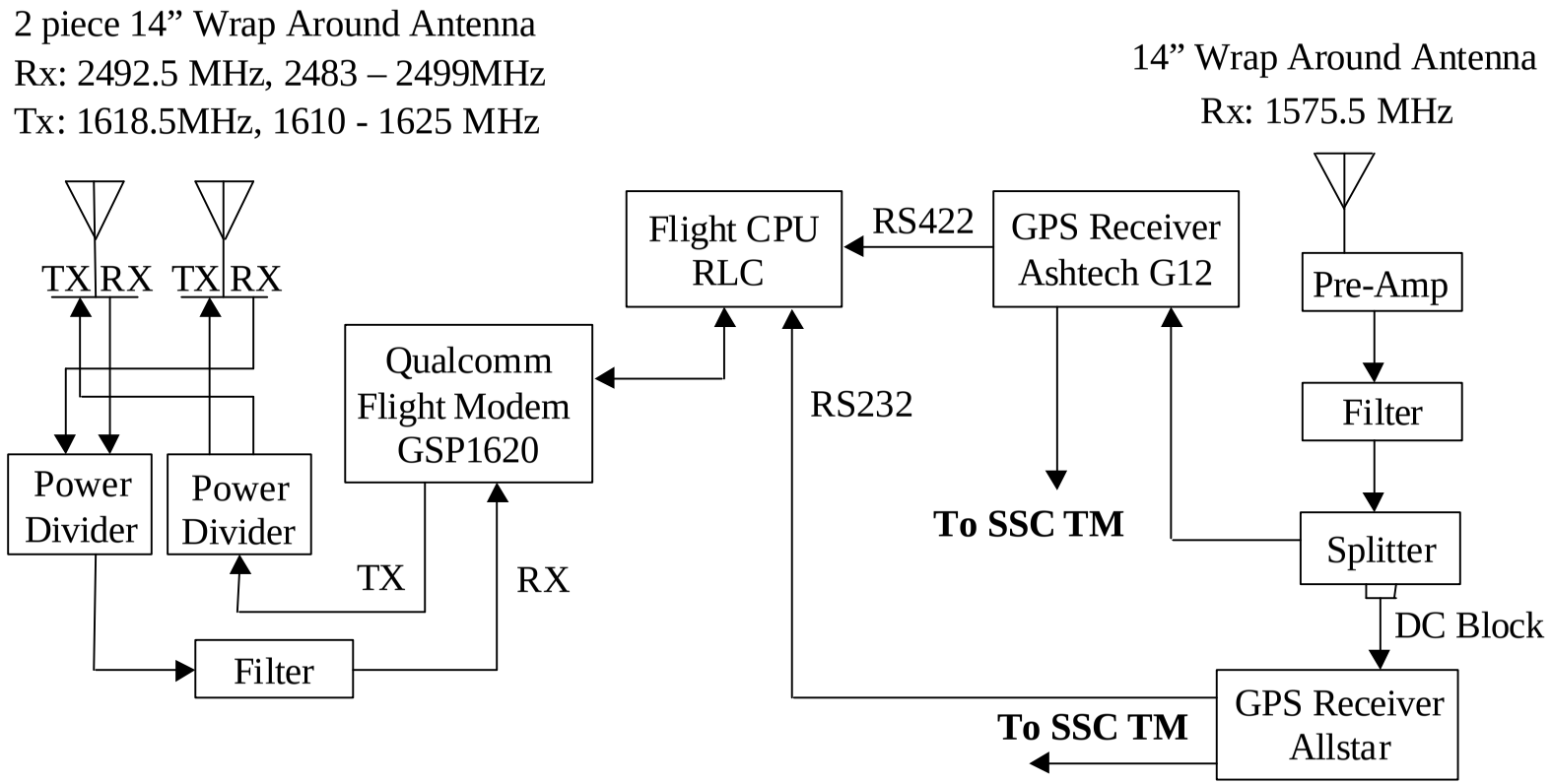


Figure 1: Flight modem sounding rocket data flow

# Coming Attractions

## Ka-Band Transition Product Review Held

Design and development activities continue on the Ka-Band Transition Product (KaTP) for Space Network (SN) and Ground Network (GN) implementations. The KaTP is a technology development, integration, and demonstration initiative to facilitate the transition of SN and GN customers to the NASA allocated Ka-band frequencies. The primary goals of the project include:

- Develop a new SN Intermediate Frequency (IF) service using the TDRS H, I, J 650 MHz channel for inclusion in the Space Operations Management Office (SOMO) Services Catalog
- Develop a GN demonstration system to demonstrate GN Ka-band operations and provide for future commercialization
- Provide a test bed within the SN and GN to demonstrate new communications technologies such as:
  - bandwidth efficient modulations
  - high data rate receivers
  - data processing/storage devices
- Provide the impetus and confidence to flight and ground system customers to utilize the NASA's allocated Ka bandwidth, by demonstrating candidate Ka-band solutions

The most recent milestone for the KaTP was the system design review—an independent peer review of the SN and GN system designs, held in December 2000. Subsequent to this review, hardware procurements were initiated for the SN and GN components. The SN and GN infrastructure implementations are scheduled for completion by the end of FY01, and the demonstrations are scheduled to be finished by the end of FY02.

Additionally, project engineers are developing requirements for the procurement of a high data rate demonstration receiver, compatible with the SN and GN IF interface. The project intends to use this receiver to perform end-to-end Ka-band data service demonstrations up to data rates of at least 600 Mbps (with a goal of 800 Mbps or higher) for both the SN and GN using technology made available by NASA and industry with limited custom development. To the extent possible and practical, these Ka-band demonstrations will include bandwidth-efficient modulation and coding techniques such as Offset Quadrature Phase Shift Keying, with baseband filtering and 8-Phase Shift Keying/Trellis Coded Modulation. The Ka-band demonstrations will occur in FY-02 in accordance with the KaTP Demonstration Plan.

*By Mark Burns/ITT Industries*

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## Automated Transfer Vehicle Preparations Progressing

In the last edition of *The Integrator*, the GSFC Automated Transfer Vehicle (ATV) team noted the recent success of testing with the European Space Agency (ESA) from Madrid with the ATV preliminary transponder. Since that time, we were fortunate enough to host a three-day meeting with our ESA counterparts here at GSFC. The purpose of the meeting was twofold: to discuss ATV/TDRSS compatibility testing, and the completion of the ATV/TDRS RF Interface Control Document (ICD).

ATV/TDRSS compatibility testing will be comprised of early engineering model transponder testing at GSFC, and later flight model/integrated systems testing in Europe. The talks during this meeting focused on the testing to be completed at the GSFC Compatibility Test Lab. ESA personnel are planning to bring their equipment to GSFC in December 2001. The ESA team is ready to proceed with test activities, and the GSFC team welcomes the idea of testing in December.

After years of dormancy, the ATV/TDRS RF ICD was also addressed, and significant progress made toward completion of the long awaited document. The document remained in limbo for a long period of time, due to uncertainties regarding the ATV communication parameters. The completion of the ATV Preliminary Design Review (PDR) confirmed design matters and the necessary information needed to complete the document.

You may notice from this article the increase in activities concerning the ATV (ATV demonstration, meeting at GSFC, ATV/TDRS Compatibility Testing in December 2001, RF ICD completion). Newly assigned ESA managers have set a launch date of April 2004 for ATV, and have adamantly stated that every effort will be made to meet this date. The break-through agreements with ESA and its contract team for ATV/TDRS Compatibility Testing are evidence that the new managers are serious about focusing on the new launch date.

The next ISS Ground Segment Control Board (GSCB) meeting is being convened at ESA facilities in the Netherlands in early April. There, GSFC and JSC ATV team members intend to meet with members of the ESA ATV team to discuss further ATV activities.

*By John Smith/CSC*

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## That "CANDOS" Attitude About Space-Based Range Safety

As mentioned in previous *Integrator* articles, the concept of space-based range safety via TDRSS has received attention from various organizations. The big question always asked is, "Do you have any hard facts—test results—that indicate the concept is feasible and that there is equipment available that can meet the need?" Although not the ultimate test, the STS 107 CANDOS (Communications and Navigation Demonstrations on Shuttle) Low Power Transceiver (LPT) experiment will provide additional insight into range safety capabilities.

The CANDOS will be carried in the STS cargo bay on a Shuttle Hitchhiker platform. The ITT members of the CANDOS team have been working with Shuttle and Hitchhiker personnel for some time to address Shuttle integration. Typically for Hitchhiker, all communication from the Attached Shuttle Payload Center (ASPC) located at GSFC is via the JSC Hitchhiker interface, through the Shuttle, to Hitchhiker avionics. CANDOS will interface through this path for initial activation and telemetry, but will also have a separate, independent interface to the White Sands Complex (WSC)/ TDRS, and also to ground stations supporting the demonstration activities. Preparations have already started to determine how best to configure the independent interface to support communications testing with TDRS, the supporting ground stations (Merritt Island, Wallops, and Dryden), and then simultaneous support via TDRS and the ground stations.

CANDOS experiments will be performed using an IP interface between the communications and telemetry system and the transceiver. As such, the configuration to transport the data from the control center to WSC and the supporting ground stations for transmission to the Shuttle/CANDOS LPT required additional investigation. The proposed solution includes converting the IP data to serial clock data and blocking/deblocking for multicast distribution to WSC and the ground stations. Interface testing in mid-February concluded successfully that the configuration between the control center and WSC would provide the necessary data transport for the TDRS portion of the experiments. At the time this article was authored, the team was working to confirm the ground configuration in a local environment. There is much more work to be completed in preparation for mission operations, but if the testing completed to date is any indication of the "CAN DO" attitude of the "CANDOS" team we expect nothing less than mission success.

*By Mike Stager/SGT, Inc. and John Smith/CSC*

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## Future NASA Space Network Architecture Study Update

Since the 1980s, the NASA Space Network (SN) has matured into a highly reliable system capable of meeting its customer needs into the 21st century. Last year, GSFC Code 450 initiated an architecture study to ensure the uninterrupted continuation of Tracking and Data Relay Satellite System (TDRSS) services beyond 2008. The ongoing Code 450 study, called the "Future Space Network Services Architecture Study," will determine the needs, possible architectures, and available technologies for a next-generation NASA SN. Work in progress on this study and the final report will be completed by the end of March 2001. The information in this article is an update to the article that appeared in the November 2000 edition of *The Integrator*.

While the study is focused on optimizing support of future near-earth missions, NASA's needs for deep space and interplanetary communications are also being incorporated. Approaches for

*(continued on page 26)*

*(continued from page 25)*

efficiently integrating the SN and Ground Network (GN) with the Integrated Interplanetary Network (IIN) architecture have been considered. A team from GSFC recently met with members of JPL's Telecommunications and Missions Operations Directorate to brief the study and discuss approaches for integrating the next generation SN into an overall IIN. By partnering with JPL, as well as other NASA centers, a unified NASA approach is being formulated for a NASA integrated communications infrastructure.

Other recent developments include the addition of lunar support requirements. NASA hopes to establish a human presence on the Moon by 2010. The operational concept for such a mission involves placing a space vehicle at the Earth-Moon L1 point that serves as the physical entry point into the lunar environment. To get to the Moon ground station, a transfer vehicle would make the 100-day trip from the International Space Station to the L1 space vehicle, where a separate operation would be required to land on the surface of the Moon. The L1 space vehicle would also serve as the communications relay between a lunar ground station and the Earth environment. The TDRSS SN is one option being considered for the communications relay network between the lunar mission and the Earth environment. Such a relay network would be required to provide continuous support to the L1 space vehicle. Additionally, continuous coverage of the transfer vehicle would also be required.

Watch future issues of *The Integrator* for updates, as this concept matures.

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## Demand Access System Available Next Year

Demand Access System (DAS) implementation is proceeding. The DAS Critical Design Review was held on February 22, 2001. DAS will augment the Space Network by providing new beamforming, receiving, and data distribution systems for telemetry data. DAS will enable customers to communicate with their platforms in exciting new ways. Real-time, 24x7 support will be available at new prices. Additional support capabilities will include automatic handover of customer service between Tracking and Data Relay spacecraft, standardized data distribution via IP, and minimal scheduling requirements.

Several customers are planning to use DAS in different ways. One customer is planning to utilize a 24x7 link, configured to listen for distress calls from the spacecraft. Others intend to have 24x7 links configured to monitor celestial events, and to relay coordinate data to the ground so that other observations can be immediately coordinated. DAS is expected to be operational in April 2002.

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Bob Tite, ITT Industries, working on DAS rack layouts

### We Are Reorganizing *The Integrator!*

Beginning with the July 2001 issue, this publication's structure will more closely mirror that of the Mission Services Program. Each section of *The Integrator* will be devoted to news and events concerning a single Project or Office within Code 450. This new structure will enable readers to quickly locate items of interest. So keep your eyes open for a new look—at least on the inside—when you receive the next issue of *The Integrator*.

# Mission Services Projects Schedule Updated

We have updated the Mission Services Projects Schedule to reflect the reorganization of Code 450. As you review the chart in the center of this issue, note that the items depicted are grouped together according to Projects within the new organization. This schedule will be updated and included with future issues of *The Integrator.*

***Edited by:*** Lena Braatz (Booz·Allen & Hamilton)
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***The Integrator*** can be accessed on line at *http://msp.gsfc.nasa.gov/integrator/.* We are in the process of revamping the Mission Services Program and Project web pages, but will continue to maintain an archive of previous issues of *The Integrator.*

If you have questions, comments, or suggestions for ***The Integrator*** newsletter, please contact:

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